A METHOD FOR REARING GROUND BEETLES (COLEOPTERA: CARABIDAE)

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ABSTRACT

A method for rearing large numbers of immature ground beetles is described. This method was successful for beetles from various northern Nearctic habitats, representing more than 80 species in 29 genera. Details are given for collection and care of gravid females, oviposition, incubation, rearing, and preservation. Success depends on providing a suitable environment, meticulous care, and perseverance.

Described below are techniques for rearing large numbers of immature ground beetles from eggs laid by field-collected adults. The success of the method depends upon providing a fitting environment for the beetles. The environment described here has proved satisfactory for rearing larvae of many different species parents collected in habitats ranging from the vicinity of glacial ice to agricultural fields. This method is similar to that described by Thiele (1968). More than 80 species representing the following genera have been reared, using this method (! indicates that some or all species were reared at least to 3rd instar): *Metrius, Carabus*!, *Calosoma*!, *Scaphinotus*!, *Sphaeroderus*!, *Nebria*!, *Pelophila*!, *Opisthius*!, *Blethisa*!, *Elaphrus*!, *Loricera*!, *Miscodera, Patrobus*!, *Diplous*!, *Platypatrobus*!, *Asaphidion, Bembidion*!, *Pterostichus*!, *Calathus*!, *Synuchus*!, *Platynus*!, *Rhadine, Agonum*!, *Amara*!, *Harpalus*!, *Bradycellus, Trichocellus, Chlaenius*!, *Metabletus*!. I was able to successfully rear 70 to 90% of all eggs used.

Collecting gravid females: Females with distended abdomens are sought in the field at time of oviposition. If tenerals (freshly emerged adults with soft, pale cuticles) of a given species occur in late summer, adults generally oviposit in spring. If tenerals occur in late spring or very early summer, oviposition takes place in mid-summer. If oviposition time is not known then gravid females may be collected when adults are most abundant. As a test, a few females are dissected and ovaries examined for degree of development.

The collected females must be kept cool to preserve their reproductive capacity. Containers must be kept out of direct sunlight at all times. Beetles can be transported to permanent quarters in picnic coolers with ice. Finally, specimens should not be overcrowded as this may inhibit egg laying.

Oviposition: Collected beetles should be transferred as soon as possible to oviposition boxes with about 1 cm of sifted moist soil (sand, loam, organic forest soil, or preferably peat moss) or very moist absorbent paper. The soil is moist enough when water stops pouring out when squeezed moderately by hand. Some females oviposit in granular substrates (field and forest species) while others readily accept moist absorbent paper (marsh-inhabiting species). Small containers should have air-tight lids; larger con-

tainers need not. I usually keep 2 males and 8 females in a box with a surface area of about 100 cm^2, but females may be kept separate in smaller boxes with or without a male. I use transparent plastic boxes so that the beetles react to a proper day length (artificial or natural). I usually feed the beetles immediately with *Tenebrio* larvae, as some females have a tendency to eat their own eggs if hungry. Since ground beetles rarely attack insects with hard cuticle I cut the *Tenebrio* into 5 pieces and give each adult one piece every other day.

Eggs may be found a few hours after the females are placed in the oviposition boxes. They may be collected immediately or any time up to a week after which they start to hatch, or they may be left in the oviposition box and young larvae collected later. For exact data about oviposition rate, the following procedure is sufficient. If females oviposit on moist absorbent paper, eggs may be counted at each time interval and then the moist paper replaced. If females of the species being studied oviposit on soil only, they are allowed to oviposit on moist sand and the eggs are collected by a flotation method (Southwood, 1966). If eggs must be kept alive, a saturated sugar solution instead of a salt solution may be used for flotation, but the collected eggs should be washed in cool water to remove the sugar coating.

Incubation of eggs: Eggs must be on a moist substrate in a cool environment; 20°C is excellent for rapid, successful development. The substrate should be a thin layer of peat moss (5 mm) over which a moist piece of paper is placed with eggs. If every larva is required for further study, the following may help to avoid cannibalism. Place a thin rectangular piece of plastic in a vial so that the corners of the plastic project onto the walls of the vials (Fig. 1). The piece of plastic serves as a small table on which is placed a moist paper with eggs. This paper must be kept moist during the incubation period. This vial is stabilized and a solution of detergent and water (3-4 drops of detergent to about one cup of water) is added to a depth

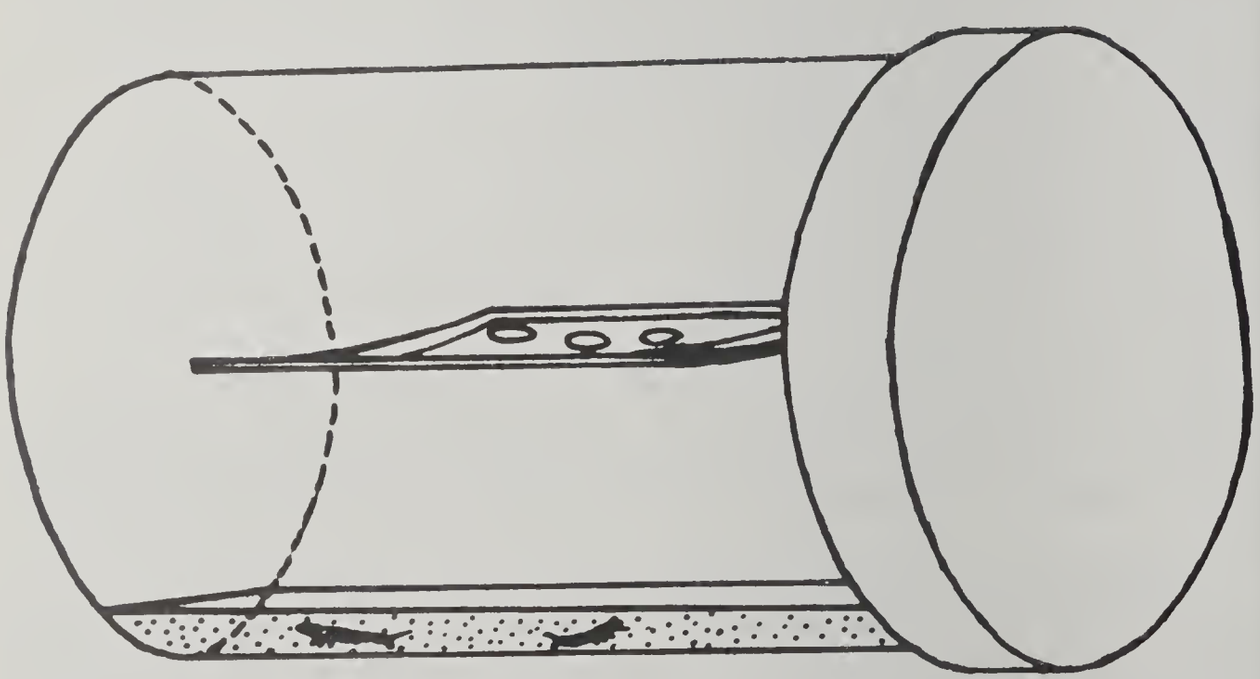

Fig. 1. Incubation box for eggs designed to avoid cannibalism. The eggs are on a moist paper over a rectangular piece of thin plastic which does not touch the back or front of the box. At the bottom is a diluted detergent solution.

of 4-5 mm. The vial is then closed with an air-tight lid. As the larvae hatch, they soon walk and reach the edge of the plastic table where they fall into the solution, sink, and become inactive. If the solution is kept around 15 to 20°C, the larvae remain alive for 12 hours. When transferred to moist paper they become active again after a few minutes.

For success in incubation, a few special points should be noted. Dead, fungused eggs should be removed daily; if not, the fungi attack healthy ones. Eggs must be handled with great care, preferably with a moist paint brush. Eggs generally hatch at the same time for each species if kept under similar conditions. The appearance of pigmented mandibles indicates that eggs at 20°C should generally hatch within 24 hours.

Rearing of larvae and pupae: This step is generally the most difficult and often results in total failure. The work is time consuming, but if the principles previously mentioned are kept in mind excellent results should normally follow. Most of the work results from the need to rear larvae singly because of their cannibalistic habits. For each medium size larva I use a small, shallow container 20 to 30 mm in diameter (Fig. 2) and with a 1-4 mm layer of moist peat moss; with early instar larvae I use less peat moss because they are hard to find at each check. A piece of *Tenebrio* larva is put along the edge of the container on an area of slightly compacted peat moss, helping the larva to find the food easily as it walks around the walls of the container. Finally the larva is carefully transferred to the container which is closed with an air-tight lid to preserve moisture. The food must be changed daily at 20°C or every other day at lower temperatures to avoid fungi. Fungi attack and kill larvae, so any contaminated food and substrate should be changed. The larvae are very pale after molting, so if exuviae are to be collected the peat moss must be carefully searched soon after moulting. If larvae of the species studied overwinter or enter diapause, use conditions reproducing natural ones (day length and temperature). While larvae are in diapause, check the container weekly to provide oxygen. Near pupation the larva builds a cell in which it lies supine. This inactivity begins 5 to 7 days before pupation at 20°C. The pupa is kept in the larval container, and any contaminated peat moss is replaced. Pupae should be checked every 2 to 4 days.

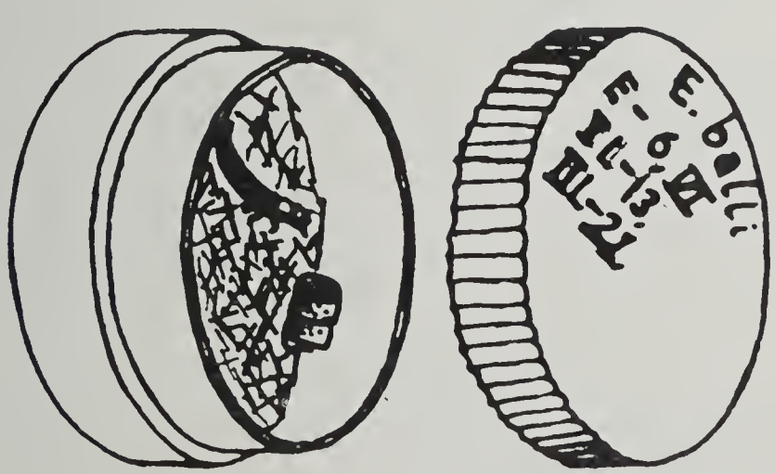

Fig. 2. Typical rearing box used for larvae and pupae showing the food position and the layer of moist peat moss.

Cool, moist conditions must be maintained, the food supply should be renewed every day or every other day, the environment must be free of fungi and mites, and the larvae and pupae must be handled very gently (I use fine forceps).

Keeping adults and reproduction: Adults are treated in the manner described for field-collected females. However, teneral individuals must not be kept with older adults for the former are easy prey in their soft condition. If adults are kept for reproduction, diapause needs (if any) must be satisfied. Each species may have its own special requirement in this respect.

Preservation of immature stages: To obtain straight larvae for preservation, place in near boiling water while alive (or recently dead), then let the water cool. In about 5 minutes the larvae are straight and ready to be stored in 70% alcohol.

Acknowledgments

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